

How to Better Inform Policy on Sustainable Productivity Growth: The Triptych of Global Agriculture

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Plenary Presentation:
Agricultural Economics Society Annual Meeting
Edinburgh, UK March 18-20, 2024



Outline

- I. Setting the Stage
- II. From Definition to Conceptualization
- III. Forces Shaping World Agriculture
- IV. Going Forward
- V. Closing Remarks



I. Setting the Stage

1. Introduction

- World approaching 10 billion people
 - Food and Nutritional Security
 - Resilient Food Supply Chain
 - Sustainable Ag Productivity Growth
 - Impact on environmental assets
- Climate change pressures
- Income inequality
- Future pandemics & emergent environmental crises
- Impact of Conflict



I. Setting the Stage

1. Introduction

- Long game
 - Operational policy challenge requires focus, commitment & leadership
 - By necessity, this challenge requires growth that is mindful of the resource limitations and preserving our natural assets.
- Tracking Progress:
 - Are efforts on measuring sustainable growth useful for policy makers?
 - Interpreting results and communicating sustainable growth policy makers.
- Policy orientation:
 - a clear definition of sustainable productivity;
 - well-defined goals, targets, and milestones; and
 - clear recommendations on effective action



I. Setting the Stage: Sustainable Agricultural Growth



Environment



Food Security



Rural Livelihood



Policy Imperative: Demand Perspective

USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

Economic
Research
Service

Economic
Research
Report
Number 323

September 2023

Scenarios of Global Food Consumption: Implications for Agriculture

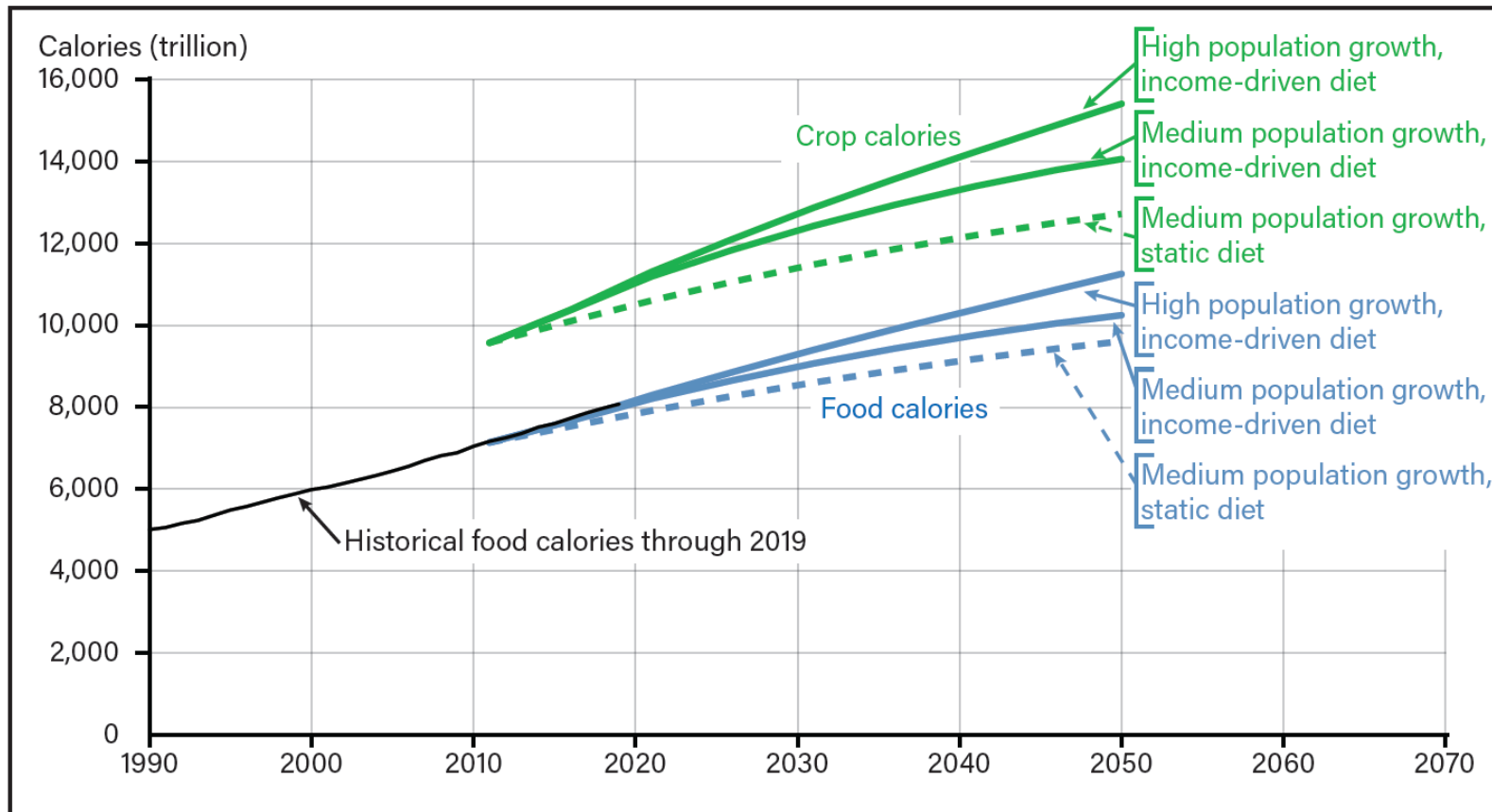
Ronald D. Sands, Birgit Meade, James L. Seale, Jr., Sherman
Robinson, and Riley Seeger

1. How do increasing population and income affect global demand for crops and food products through 2050?
2. What is the effect of agricultural productivity growth on food prices and cropland area expansion?



Population and Income Drive Projections of World Food Consumption

Projections of world food calories and crop calories, 2011–50



- A useful measure of the size of the world agricultural system is total calories from crops
- Rising per capita incomes have historically implied increasing consumption of
 - Total calories
 - Animal products

Notes: Three illustrative scenarios are shown: a static diet (per capita consumption of food calories remains constant at 2011 levels in all world regions) with medium population growth; an income-driven diet with medium population growth; and an income-driven diet with high population growth. The static diet is a point of comparison to quantify the effect of income growth on food consumption.



Policy Imperative: Supply Perspective

By-production framework (Good and Bad Netputs)

- Desirable (marketed) outputs
- Undesirable (bad) outputs
- Mitigating output activities

Environment assets:

- No longer a free inputs or valueless output



Policy Imperative: Market Perspective

- Accounting for environmental service and assets
 - Institutionalizing ecosystem services markets
 - Nontraditional commodity markets (think carbon)
- Private versus Social costs
 - Local decisions driven private (firm-level) costs
 - Regional and Global decisions/policies driven by social costs



2. Sustainable Growth Definitions

We like the vibe, but debate over the core concept to measure

First, Who are the Stakeholders:

- Farm businesses
- Environment
- Health
- Communities
- Society



2. Sustainable Growth Definitions: United Nations (SDG 2)

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG 2.3: By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.

SDG 2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.



2. Sustainable Growth Definitions: OECD

Building sustainable agriculture and food systems in a changing environment: Shared challenges, transformative solutions

(Nov 2022 Ministerial Meeting)

...the agricultural sector needs to do more with less, and sustainable productivity growth has to increase significantly.

Average global agricultural productivity will need to increase by 28% over the next decade – more than triple the increase recorded in the last decade – in order to achieve the Zero hunger target (SDG 2) while simultaneously keeping agricultural emissions on track to reach the Paris Agreement targets.

Take several new actions to measure the agriculture and agri-food sector's progress towards environmental sustainability



2. Sustainable Growth Definitions: USDA

[Sustainable Productivity Growth Coalition | USDA](#)

Voluntary coalition of action with 120 members aims to accelerate the transition to more sustainable food systems through productivity growth that optimizes agricultural sustainability across social, economic, and environmental dimensions.

Sustainability must balance economic, social and environmental dimensions.

USDA bases its approach to agricultural sustainability on two definitions, both of which incorporate the three dimensions of sustainability:

- Satisfying human needs;
- Enhancing environmental quality, the resource base, and ecosystem services;
- Sustaining the economic viability of agriculture



Toward Measuring Sustainable Growth in Agriculture

- Tracking Progress
 - Within a nation
 - Between nations and regions
- Multiple measures
 - No Single measure sufficient
 - Triangulate
- Total Factor Productivity Network and the Environment (OECD)
 - Focus on Environment



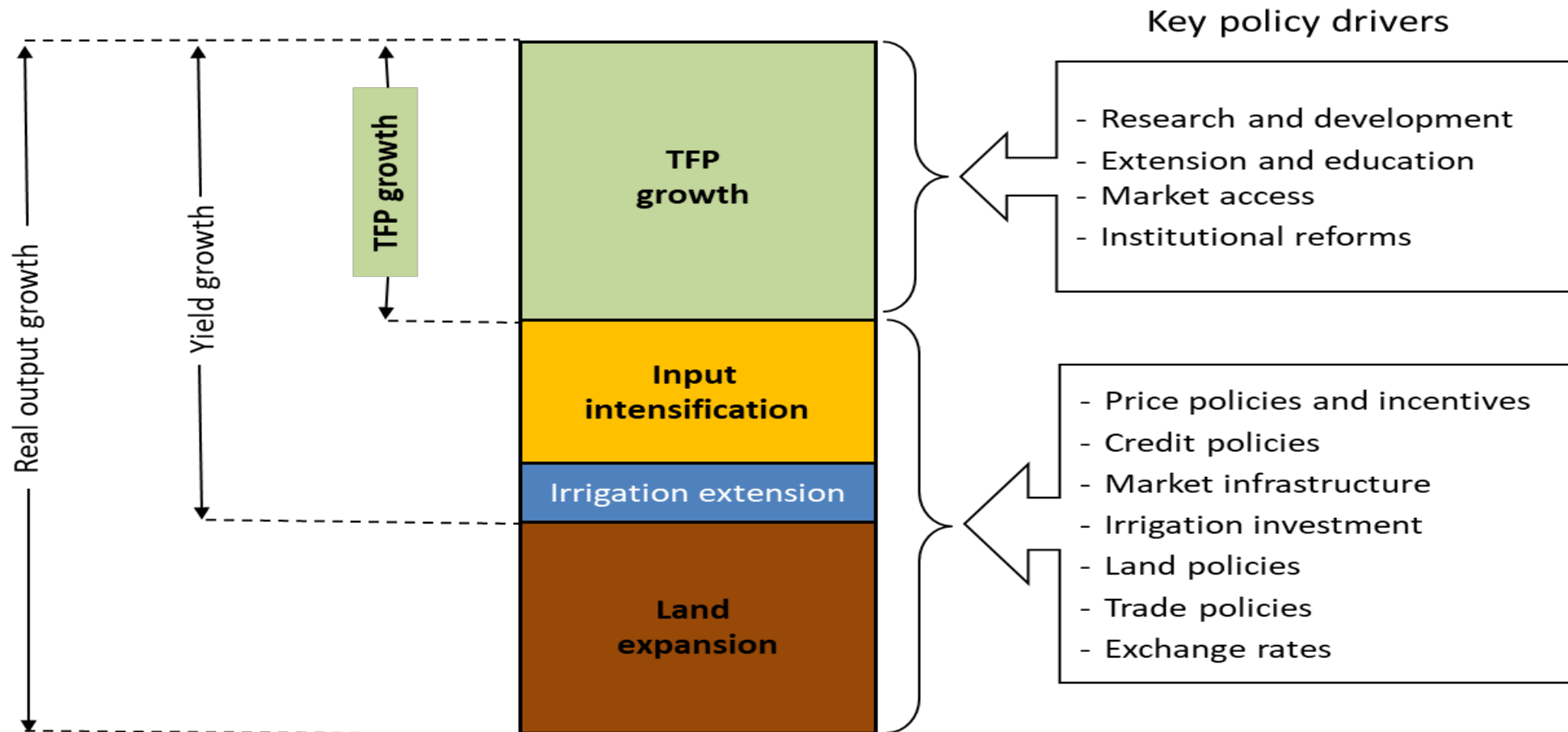
Role of Innovation, R&D and TFP

Total Factor Productivity (TFP)

- Ratio of Outputs realized to Resources allocated
- Agricultural as a natural resource-based system
- Measure of our ignorance



Role of Innovation, R&D and TFP



II. From Definition to Conceptualization

1. TFP growth as a component of Sustainable Productivity Growth

2. Focusing on the Policy Challenges

- Across countries we have common end goals. Policy and stakeholder challenges
- Target: to minimize the impact of agricultural production on environmental degradation at a minimum, and seek to enhance the environmental asset base;
- Paths to get there vary.
- Output- and market oriented (Climate smart), adaption, mitigation, resilience.
- Input-oriented approaches



II. From Definition to Conceptualization/2

3. Facilitating and Promoting Growth

- This does not have to be a trade-off situation between ag output vs. environmental preservation improvement (zero-sum game).
- This can be a win-win:
 - land-saving activity,
 - water-use saving/water quality gaining,
 - soil health enhancing
 - GHG-reducing activity
- The productivity series we generate will be used as a benchmark to guiding policy efforts in where to target future policy efforts and data generation



II. From Definition to Conceptualization/3

4. Innovation & Creative Solutions

- role for ag science innovation
- role of creative economic mechanisms (incentives, markets) to effect change
- facilitating market development and growth (emissions trading schemes, creating credibility in these markets – carbon intensity measurement)



III. Forces Shaping World Agriculture

World Agricultural Production, Resource Use, and Productivity, 1961-2020

Keith O. Fuglie, Stephen Morgan, Jeremy Jelliffe

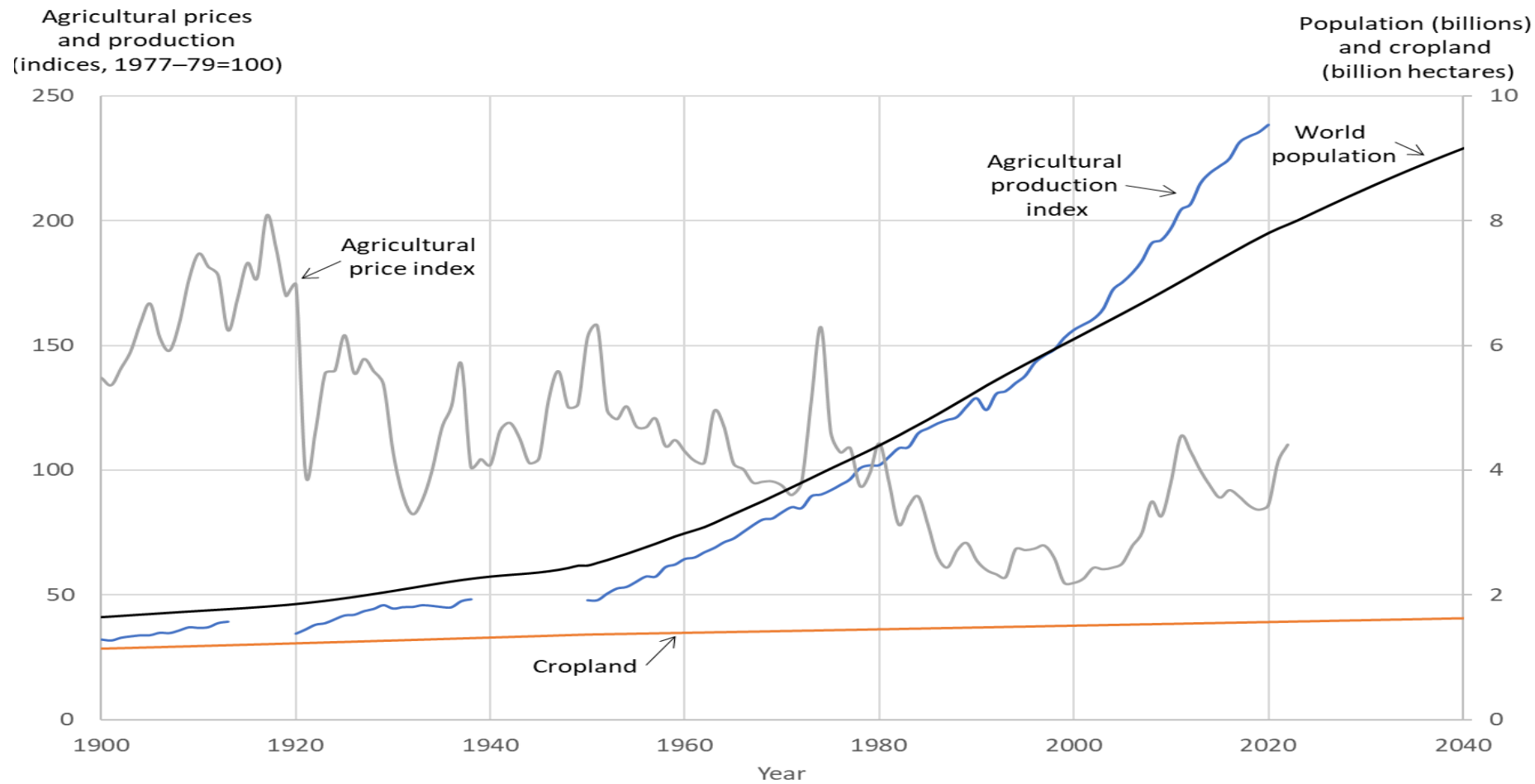


1. International Comparisons (1961-2020)
 - Ag Output increased 4x
 - Population increased 2.6x
 - 53% ↑ ag output per cap
 - Real food prices ↓ relative general price level
 - Most growth from ag productivity gains
 - Production shifting to Global South
 - Share ↑ from 44% to 75%

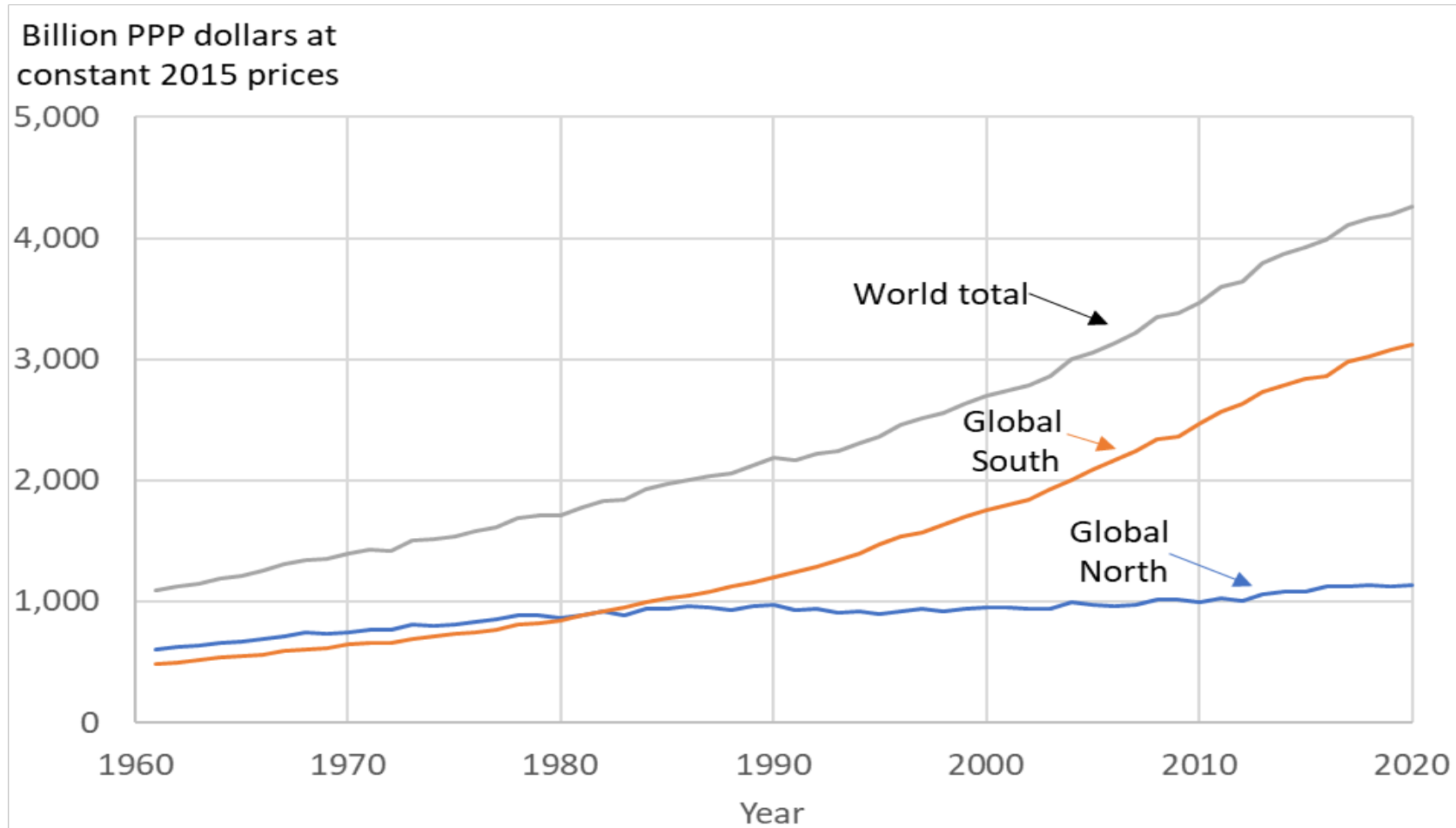


World agricultural output, price, cropland, and population since 1900 (Fig 1)

From Fuglie et al, 2024



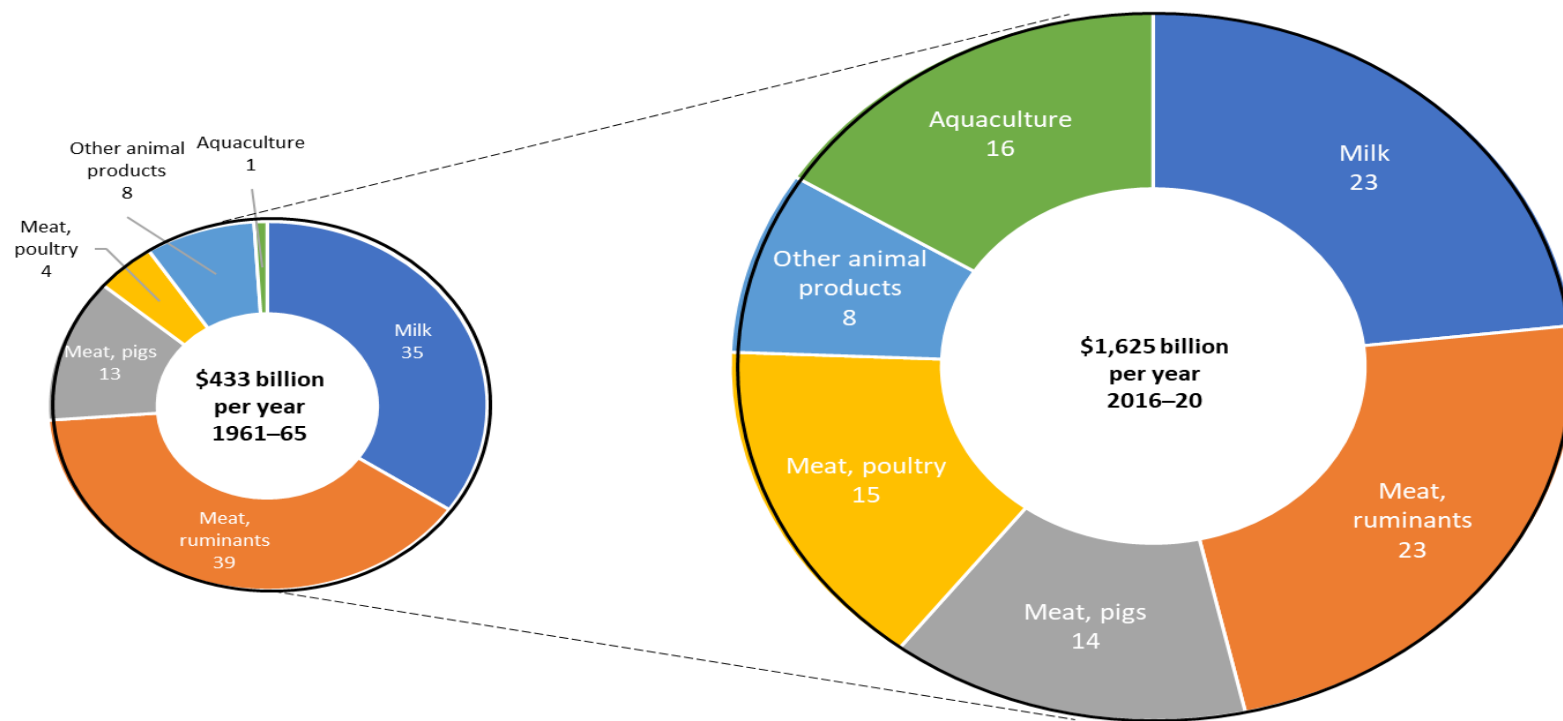
World agricultural output in the Global North and Global South, 1961–2020 (Fig 3)
From Fuglie et al, 2024



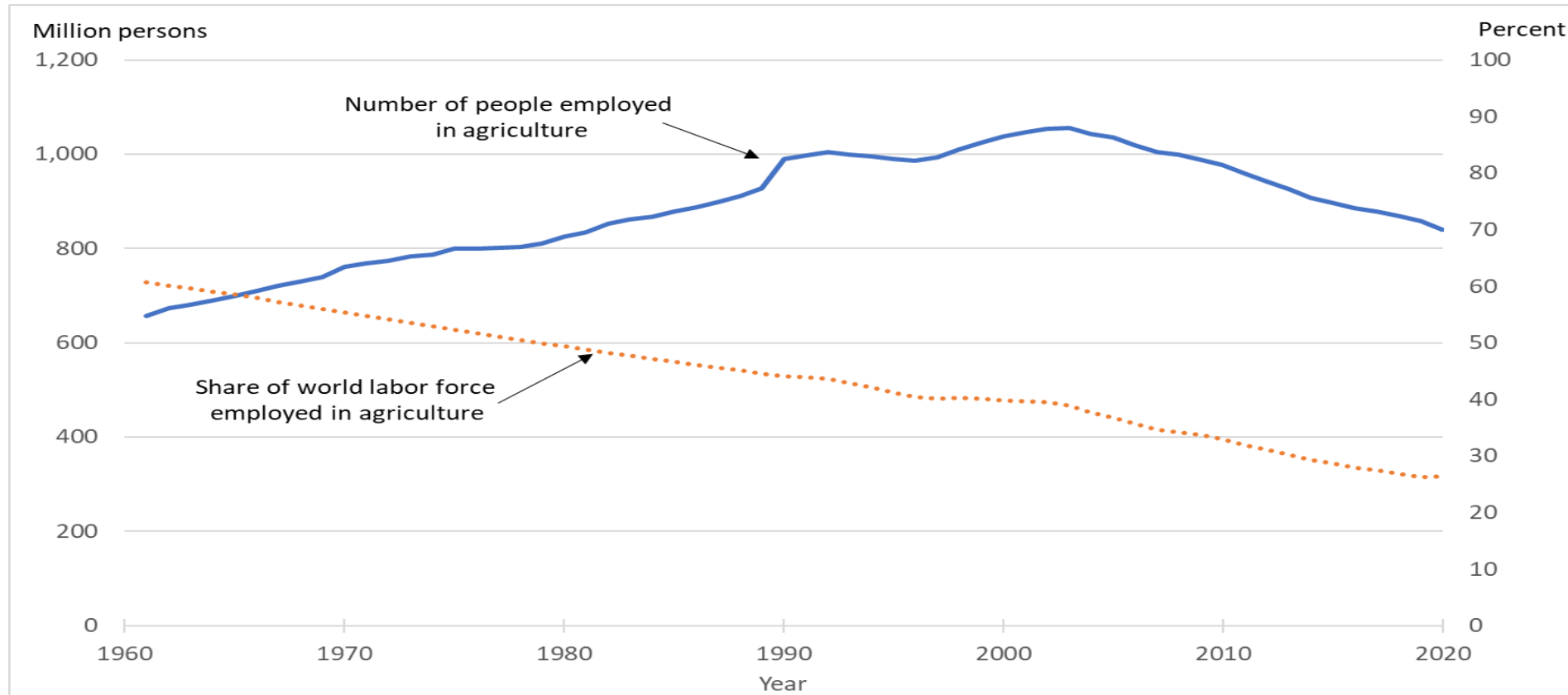
Diversification in global animal and aquaculture production, 1961–65 and 2016–20 (Fig 6)

From Fuglie et al, 2024

Global animal output and output growth by product, 1961–65 and 2016–20, average annual value at constant 2015 prices (percent)

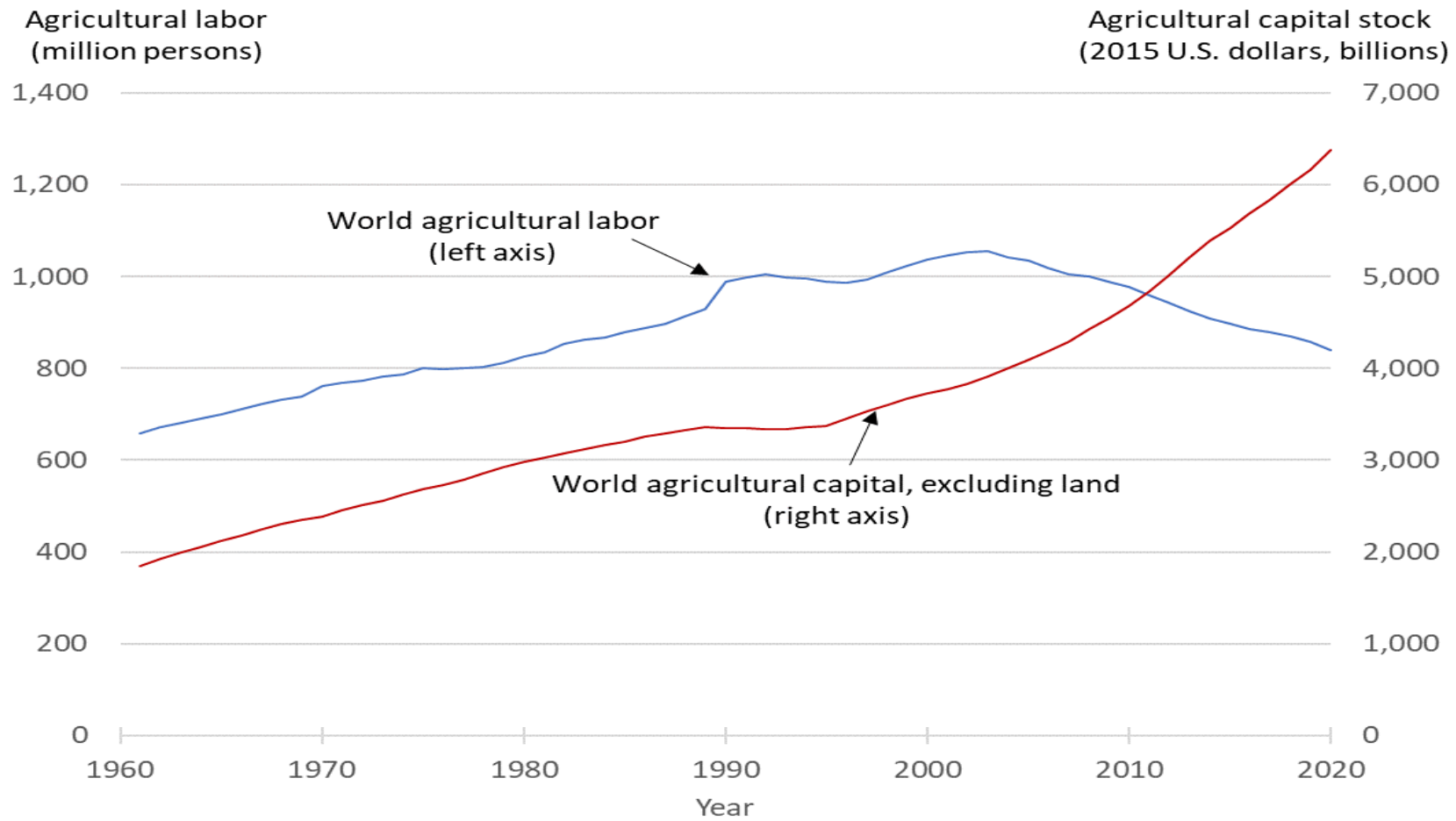


World agricultural employment and agriculture's share of total employment, 1961–2020 (Fig 9)
From Fuglie et al, 2024

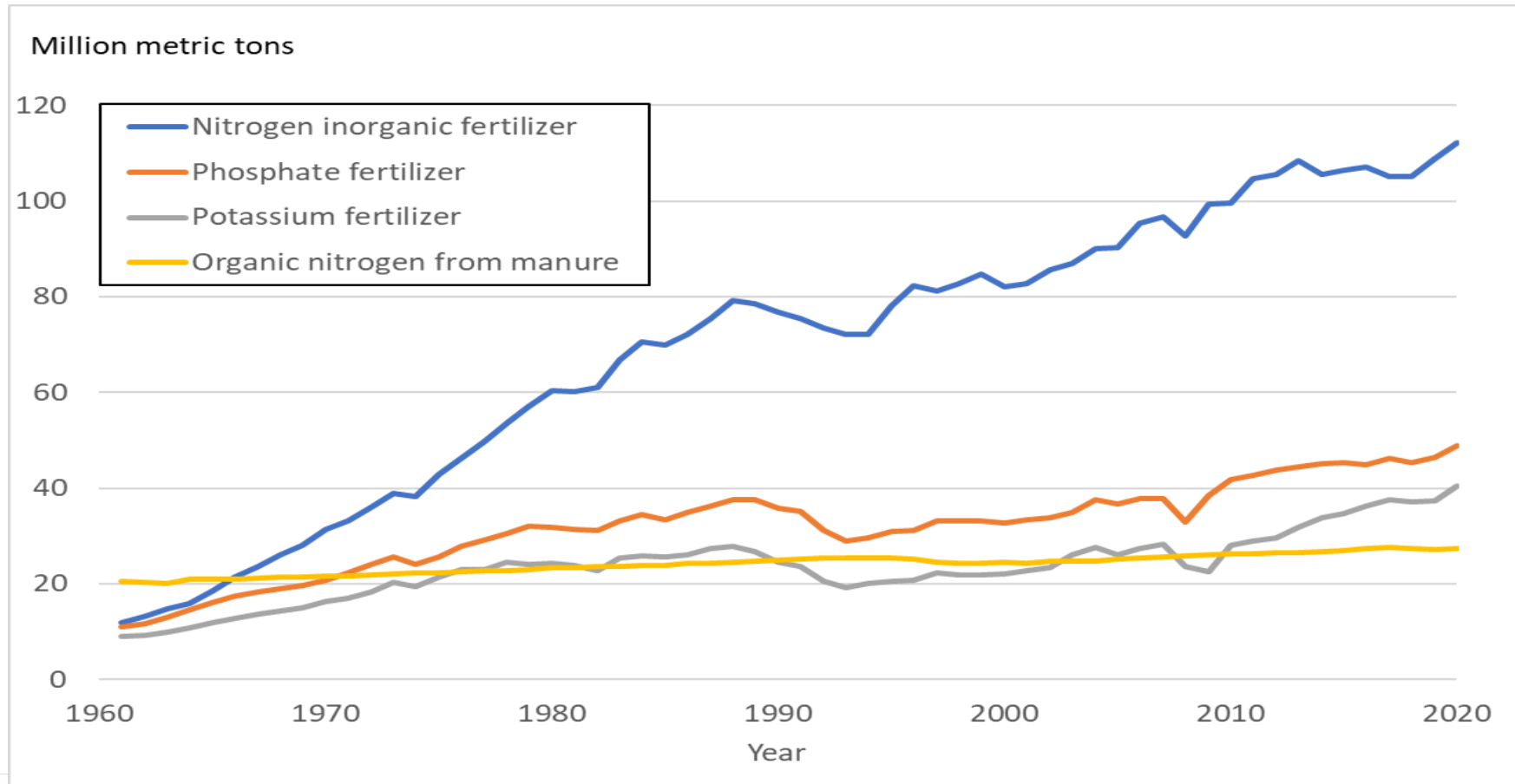


World agricultural labor and capital stock, 1961–2020 (Fig 10)

From Fuglie et al, 2024

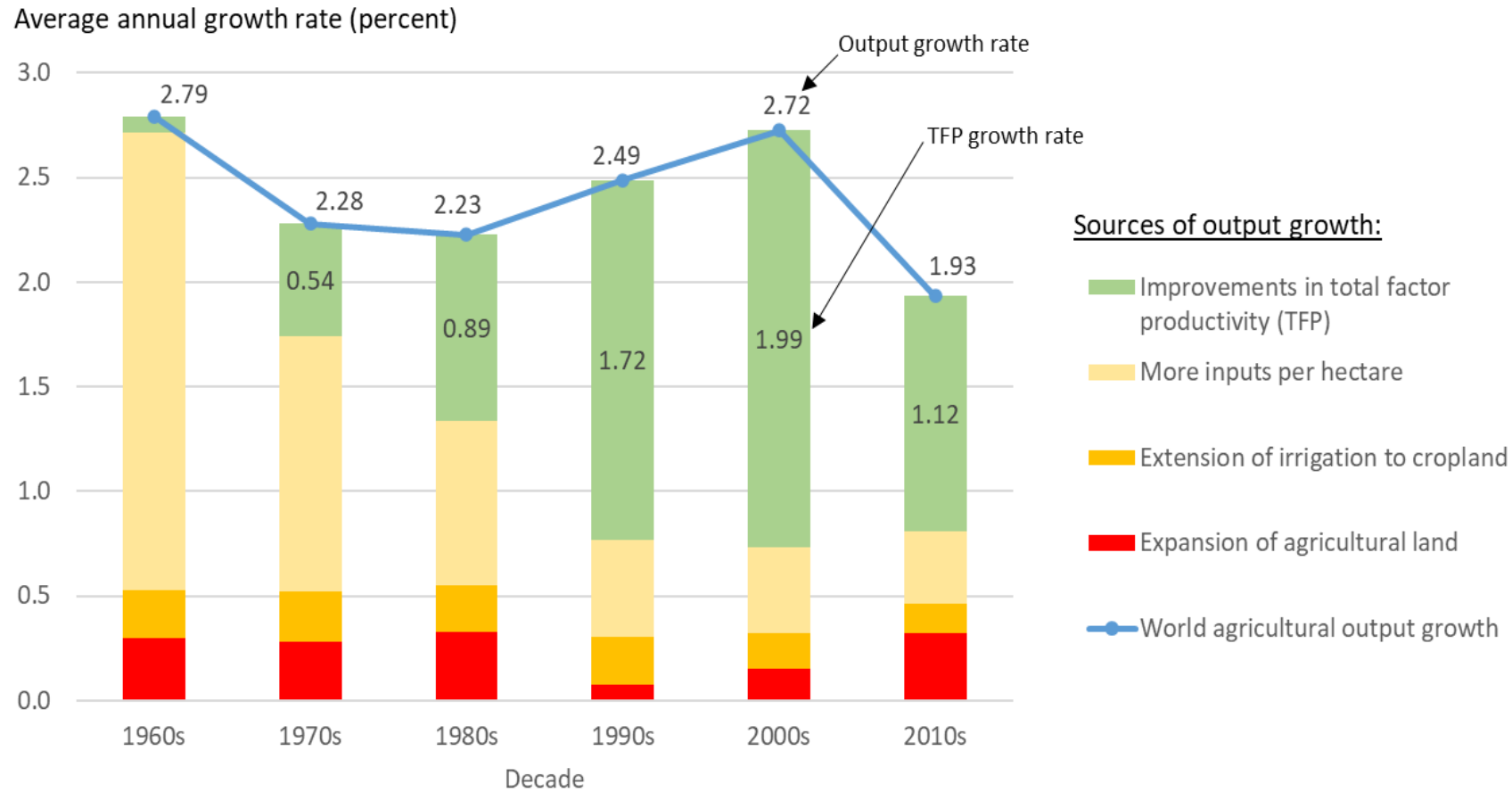


Quantity and composition of agricultural fertilizers applied worldwide, 1961–2020 (Fig 12) *From Fuglie et al, 2024*

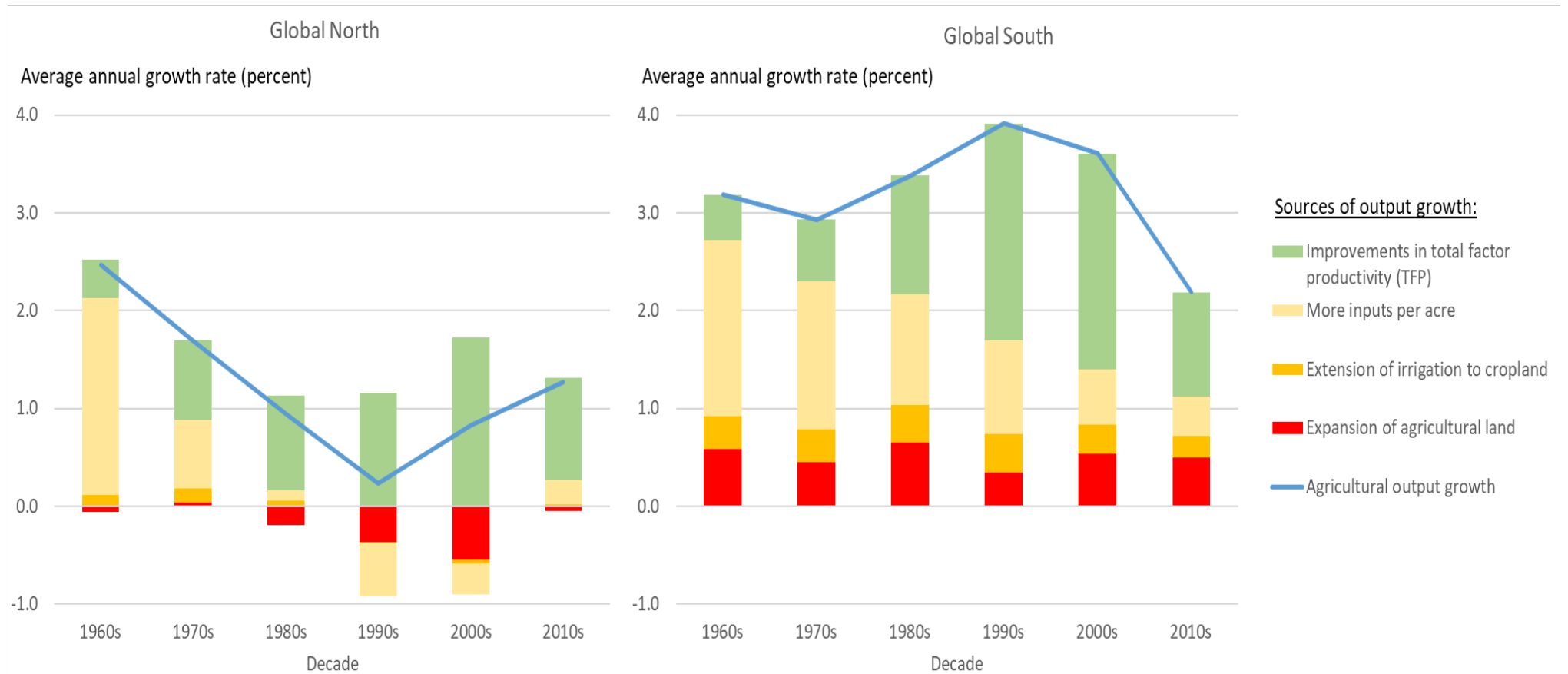


Sources of growth in world agricultural output by decade, 1961–2020 (Fig 18)

From Fuglie et al, 2024



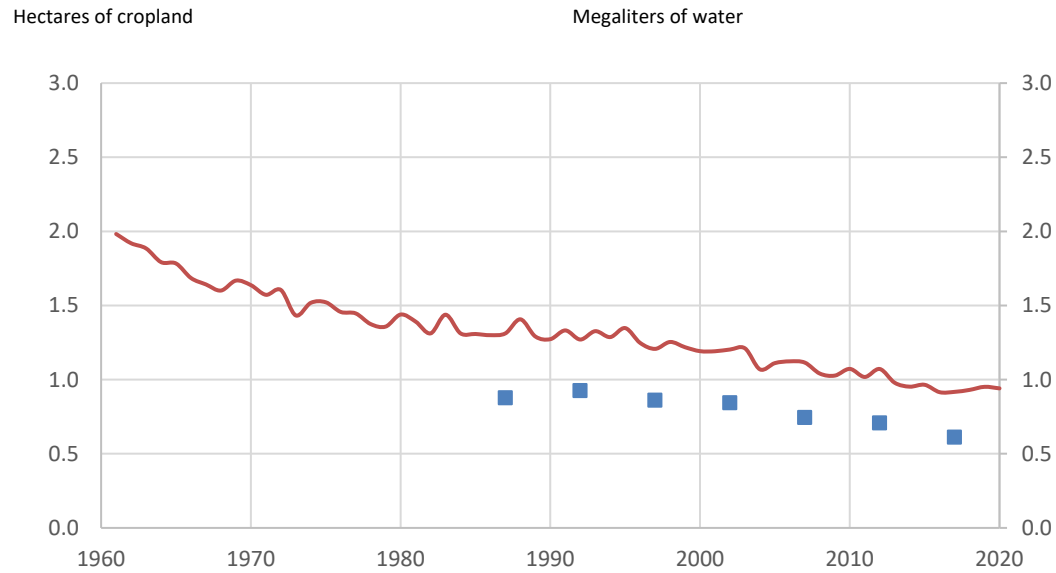
Sources of growth in agricultural output in the Global North and Global South by decade, 1961–2020 (Fig 19) *From Fuglie et al, 2024*



Agriculture and the Environment: Cropland and Water Use Intensity (Fig 21)

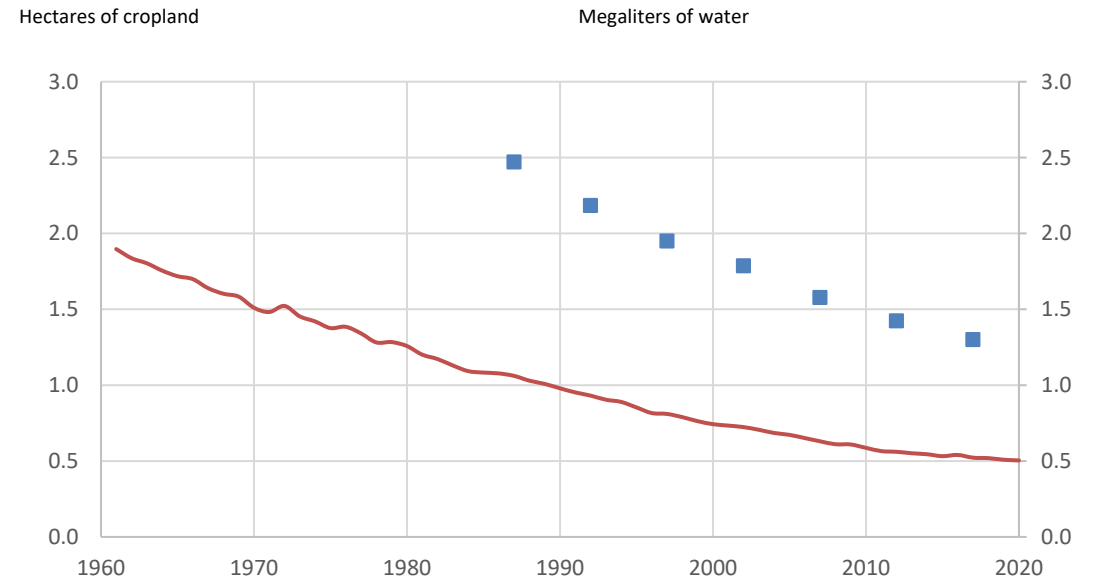
From Fuglie et al, 2024

Global North cropland and water use intensity



— Cropland per \$1,000 of crop output ■ Irrigation water per \$1,000 of crop output

Global South cropland and water use intensity



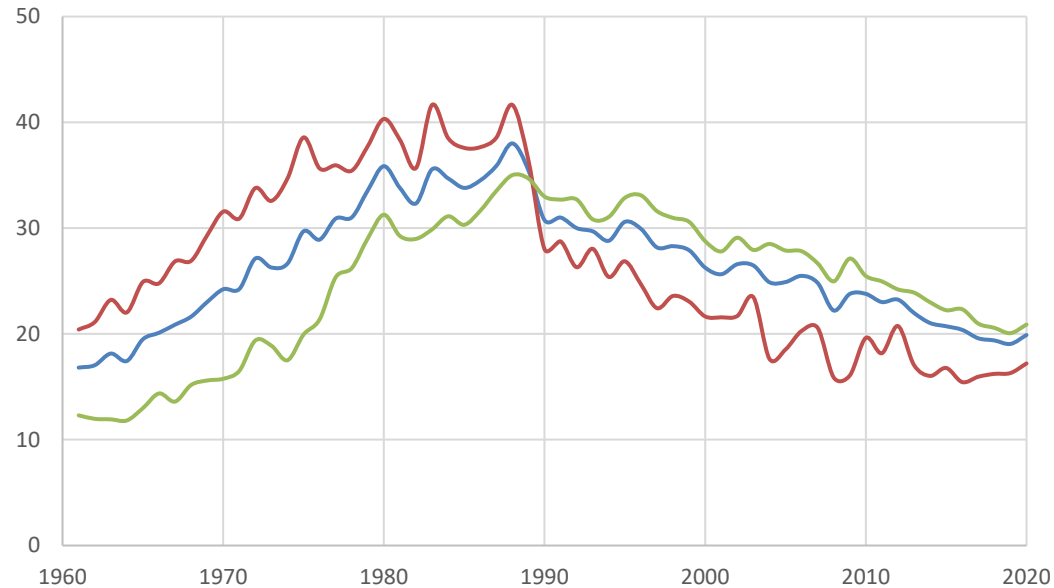
— Cropland per \$1,000 of crop output ■ Irrigation water per \$1,000 of crop output



Agriculture and the Environment: Agricultural nutrient loadings & nutrient-loading intensities, 1961–2020 (Fig 22) *From Fuglie et al, 2024*

Nitrogen loading intensity

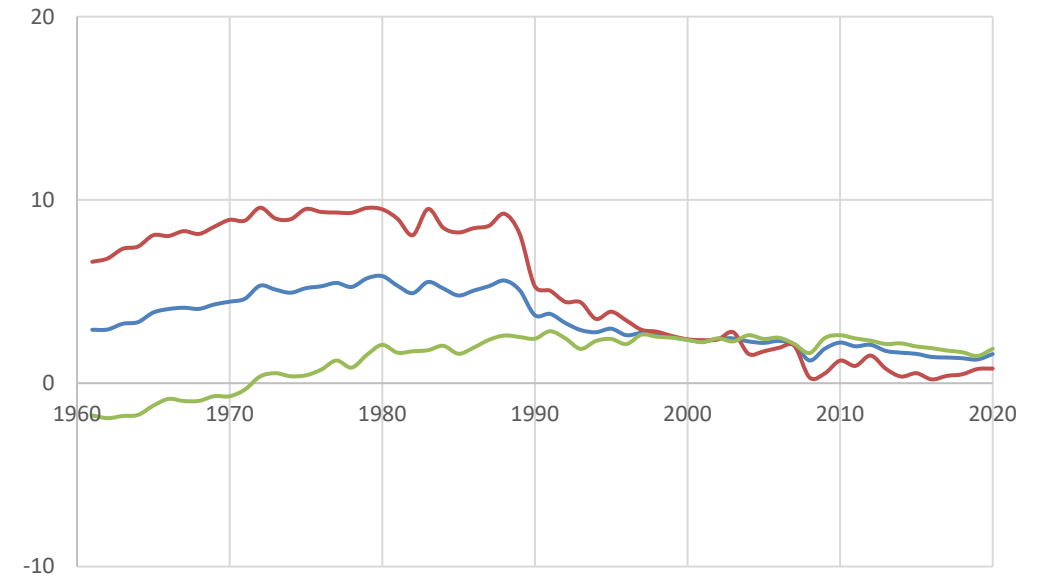
Kilograms per \$1,000 of agricultural output



— World — Global North — Global South

Phosphate loading intensity

Kilograms per \$1,000 of agricultural output



— World — Global North — Global South

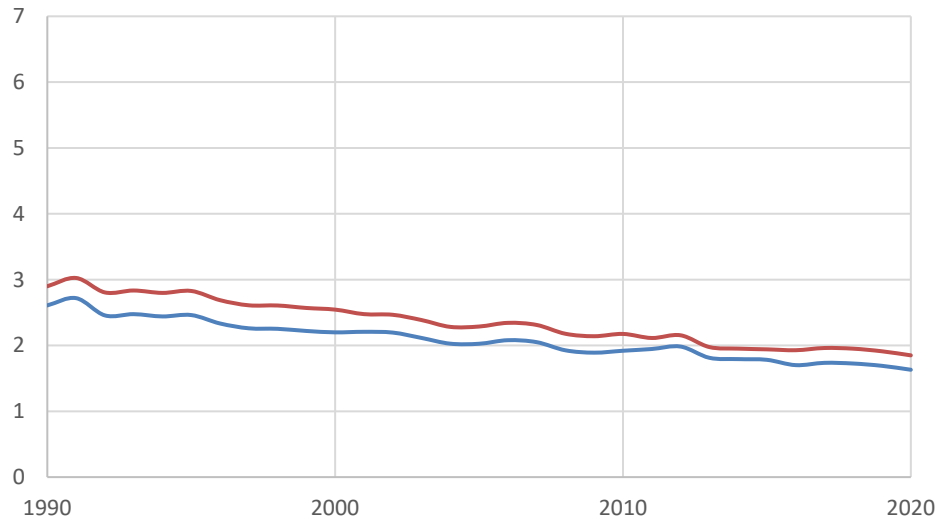


Agriculture and the Environment: Agricultural GHG emissions & emissions intensities, 1990–2020

(Fig 23) *From Fuglie et al, 2024*

Global North agricultural emissions intensity

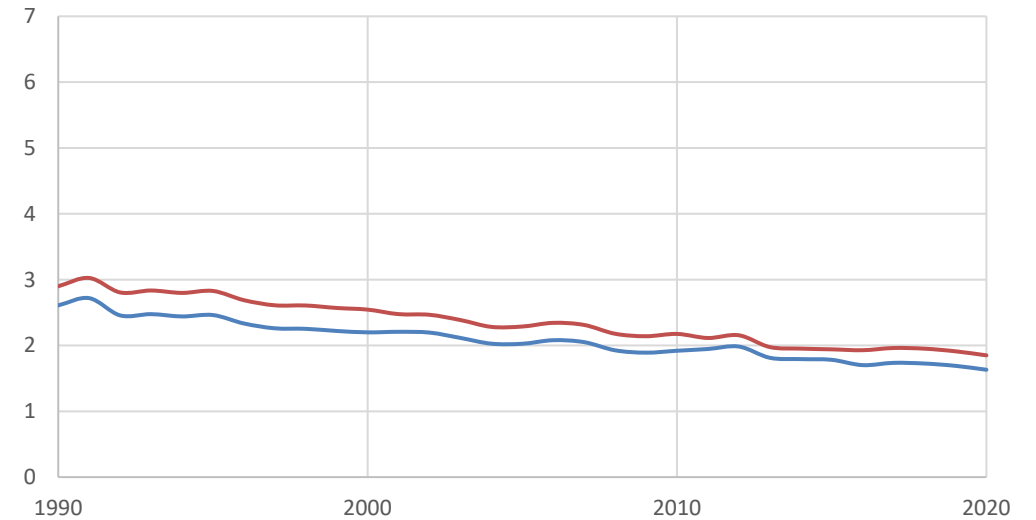
Kilograms of carbon dioxide equivalent per \$1,000 of agricultural output



— Emissions from farm production — Emissions from farm production and land use change

Global North agricultural emissions intensity

Kilograms of carbon dioxide equivalent per \$1,000 of agricultural output



— Emissions from farm production — Emissions from farm production and land use change



Agriculture and the Environment: OECD

- Environmental Indicators at a Glance

[Environment at a Glance Indicators – United Kingdom \(oecd-ilibrary.org\)](https://oecd-ilibrary.org/environment-at-a-glance-indicators-united-kingdom)

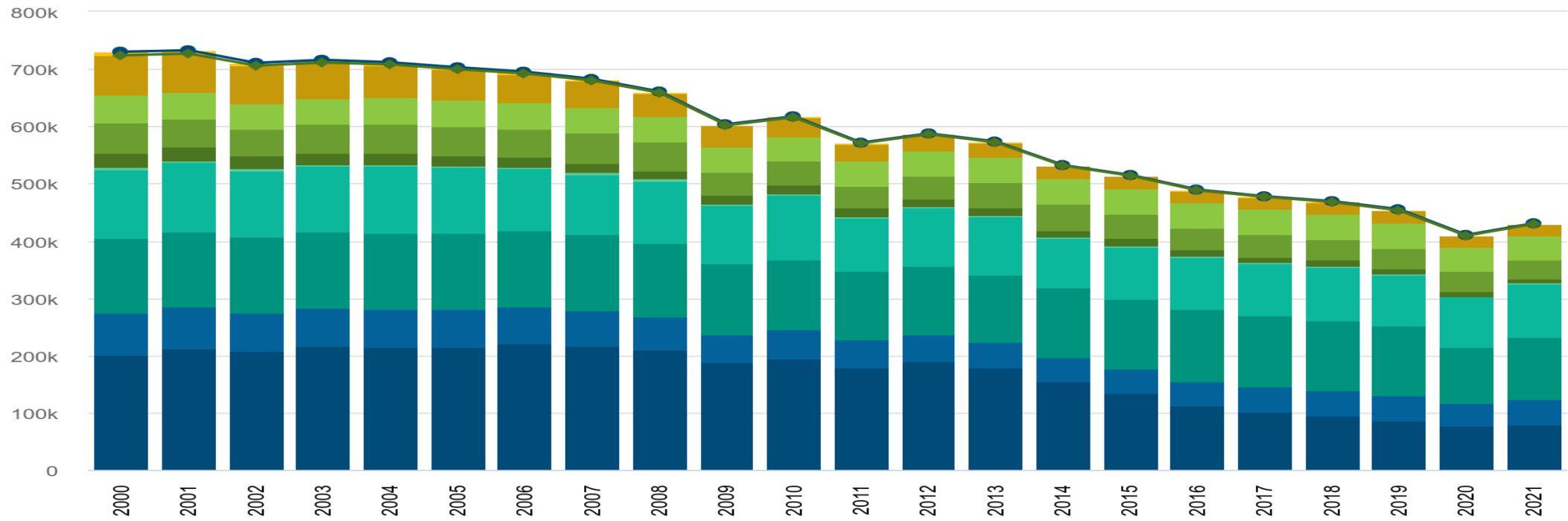
- Country reports
- Indicators:
 - Climate Change
 - Air Quality
 - Freshwater Resources
 - Circular Economy – Waste & Materials
 - Biological Resources & Biodiversity
 - Sustainable Ocean Economy



Agriculture and the Environment: OECD

United Kingdom - GHG emissions by source
 Thousand tonnes CO2 equivalent

- 1A1 - Energy Industries
- 1A3 - Transport
- 1A5 - Energy - Other
- 2 - Industrial processes and product use
- 5 - Waste
- Total emissions including LULUCF
- 1A2 - Manufacturing industries and construction
- 1A4 - Residential and other sectors
- 1B - Fugitive Emissions from Fuels
- 3 - Agriculture
- Land use, land-use change and forestry (LULUCF)
- Total emissions excluding LULUCF

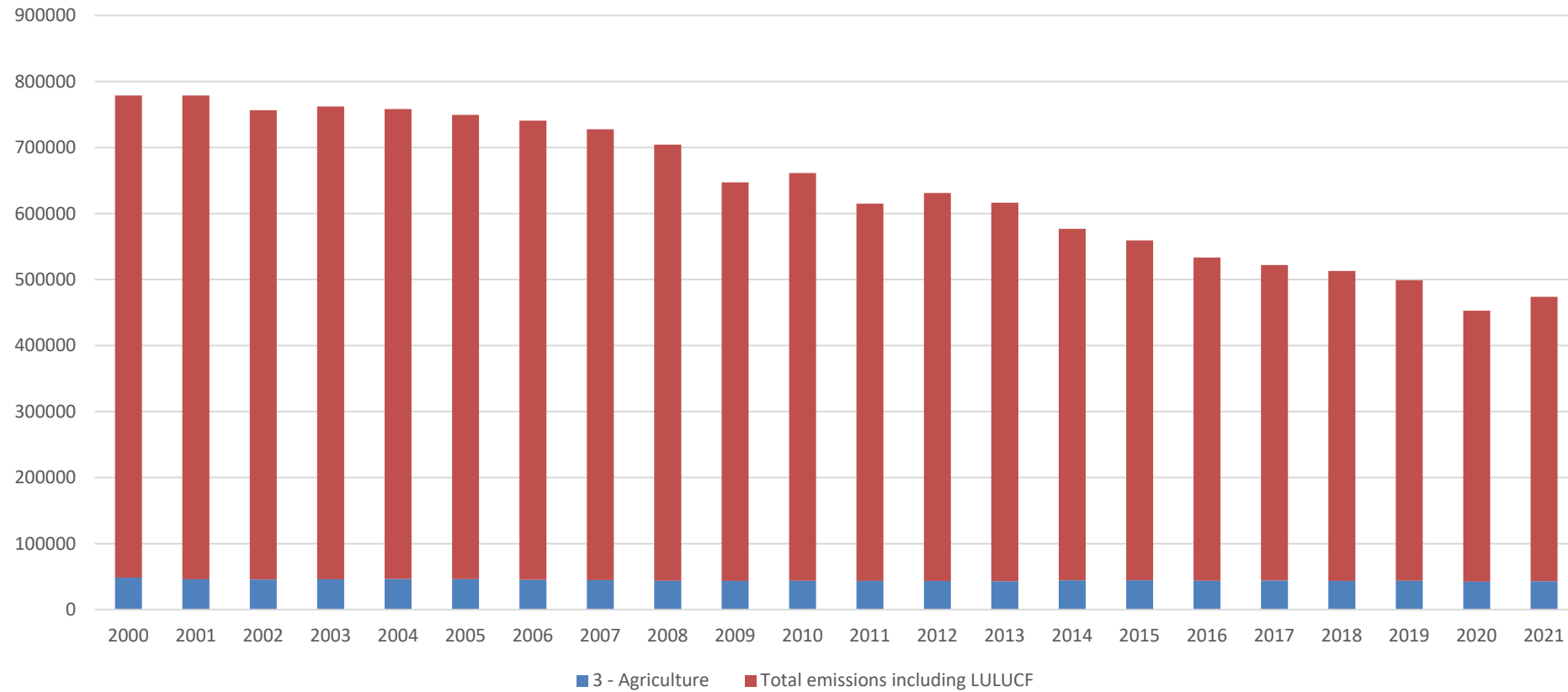


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Agriculture and the Environment: OECD

United Kingdom Agriculture GHG emissions



IV. Going Forward

○ 1. Brief History of Data

1st Wave: Observational

- Theory based, scarce data
- High impact on policy

2nd Wave: Data confront Theory

- Emergence of official statistics
- Computing power emerges
- National statistics produced with lag; industrial based
- Policy waiting for the data?

3rd Wave: Data improves Theory

- High frequency data
- Challenge to process it to meaningful information



IV. Going Forward

(Brief History of Data)

4th Wave (current) Data is the foundation for evidence building

- Real time monitoring: Emerging issues & Anticipating trends
- Food supply forecasting
- Design & collect internationally accepted common indicators
- National statistics tell one picture
- Not capturing the heterogeneity of impacts on equity, for example



IV. Going Forward

- Local-Global-Local (heterogeneity)
- Monitoring, Measuring, Reporting and Verification (MMRV)
 - Recognizing new data coming online
 - Collaboration with climate and ag sciences



V. Closing Remarks

- Leadership Challenge
 - International effort
 - Return to the policy maker orientation
 - a clear definition of sustainable productivity;
 - well-defined goals, targets, and milestones; and
 - clear recommendations on effective action
 - Assess and revise
- Theory, Models and Data
 - Theory driving model development and data
 - Data Driving Theory and Model?
- Data are evolving
- Who provides the next wave of data?
- Communication Challenge



Citations

Fuglie, K.O., Morgan, S., & Jelliffe, J. (2024). World agricultural production, resource use, and productivity, 1961–2020 (Report No. EIB-268). U.S. Department of Agriculture, Economic Research Service.

OECD, *Declaration on Transformative Solutions for Sustainable Agriculture and Food Systems*, OECD/LEGAL/0483

Sands, R., Meade, B., Seale, Jr., J.L., Robinson, S., & Seeger, R. (2023). *Scenarios of global food consumption: Implications for agriculture* (Report No. ERR-323). U.S. Department of Agriculture, Economic Research Service. <https://doi.org/10.32747/2023.8134356.ers>

UN (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution Adopted by the General Assembly on 25 September 2015, 42809, 1-13. <https://doi.org/10.1007/s13398-014-0173-7.2>

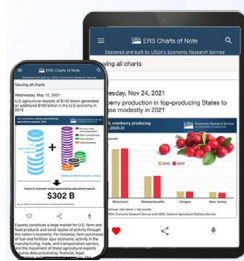
<https://www.usda.gov/oce/sustainability/about-spgc>



Questions?



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